

**LSAA**  
Sustainable Lightweight Facade System 29 October 2009 **aurecon**

**LSAA definition: Lightweight Structure**

“ A lightweight structure can be termed as such, when, regardless of the type of material employed, the shape of the structure is determined through an optimisation process to efficiently carry the loads from a critical loading case.”

**aurecon**

**A definition: Sustainable Lightweight Structures**

“ A lightweight structure can be termed as such, when, regardless of the type of **material** employed, the **shape** of the structure is determined through an optimisation process to efficiently carry the loads from a **critical loading** case.”

- Material:** material, type, construction or use / function
- Shape:** form, plan, section or overall –derived from energy lines – structure, heat flow and carbon foot print
- Critical load** environmental influence -social (health), environment (carbon footprint – embodied and operation) and productive efficiency (economic).

**aurecon**

**Façade – Influence on Sustainable design**

**CRITICAL LOADS**

**Environment (Energy / Carbon):**

- Embodied
- Sequestration
- Operation
- Reuse / deconstruct

**Social (Health) Impact:**

- Indoor Environmental Quality
  - Thermal
  - Air quality
  - Light and views
- Safe design and construction
- Image – education and metaphor

**Economy:**

- Modular
- Efficient /Cost effective
- Life cycle / whole of life costing
- Impact on rating systems

*Design - Operate - Regenerate - Reuse / deconstruct - Indoor Environmental Quality - Safe design and construction - Modular - Efficient /Cost effective - Life cycle / whole of life costing - Impact on rating systems*

**aurecon**

**Facade: Typology and Materials**

**Typology:**

- Curtainwall
- Feature walls
  - entry and roof

**Materials**

- Steel
- Aluminium
- Glass
- Timber

**aurecon**

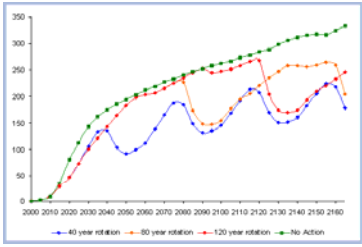
**An alternate Material - Bamboo**

**Processed**

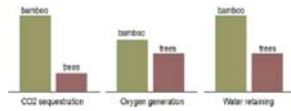
**Natural**

**aurecon**

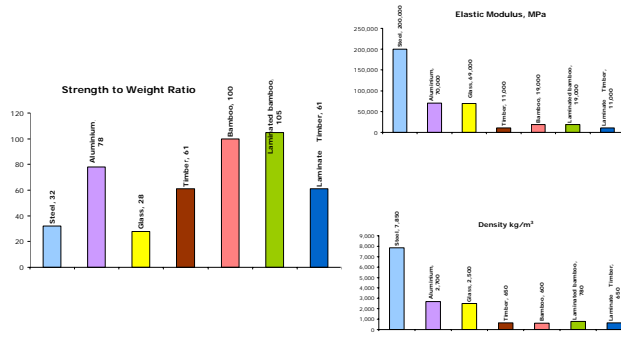
Difference between timber and Bamboo



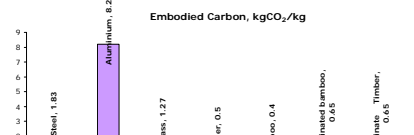
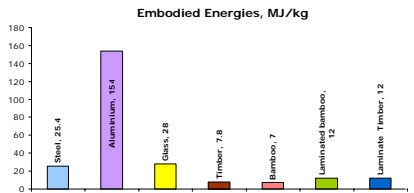
- Sequestration
- Harvest & crop rotation
- Grass like, fast growing
  - 75 genera, 1250 species, 22 million Ha, 2000 million tonnes



Materials - How do they compare



Materials – embodied energy / carbon

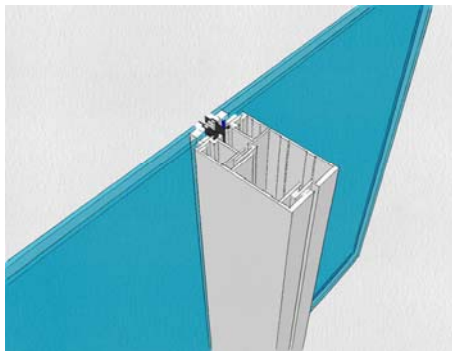


Comparison of Materials

Material	Steel	Aluminium	Glass	Timber	Bamboo	Laminated Bamboo
Density kg/m³	7,850	2,700	2,500	650	600	780
Strength / weight	32	78	28	61	100	105
Modulus, E	200,000	70,000	69,000	11,000	19,000	19,000
Embodied Energy (MJ/kg)	25.4	154	28	7.8 [12]*	7	12
Embodied carbon (kgCO₂/kg)	1.83	8.21	1.27	0.50 [0.65]*	0.40	0.65
Expected life (years)	>50	>50	>50	Up to 25	Up to 25	Up to 25



Example #1 - Aluminium Curtainwall

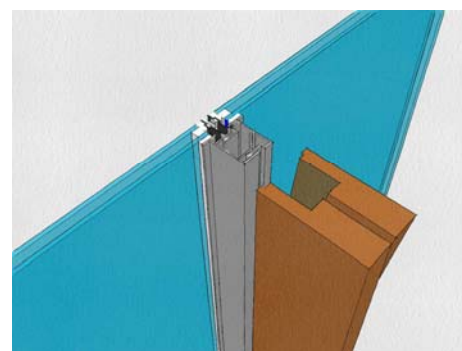


Mass Aluminium (kg/m²)	5.7
Mass Timber (kg/m²)	-
Mullion U-value (W/m²K)	10.3
Panel U-value (W/m²K)	2.38
Embodied carbon of mullions (kgCO₂/m²)	46.7
Embodied energy of mullions (MJ/m²)	878

Based on Panel size of 1.5m x 3.8m with vision of 2.8m and spandrel 1.0m



Example #1 - Laminate Bamboo stiffened Aluminium Curtainwall

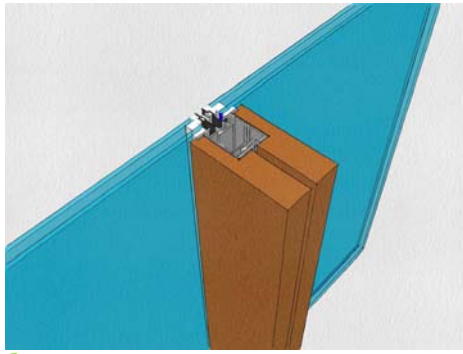


Curtainwall aluminium section optimised for handling and transom

Add laminated Bamboo to stiffen mullion



Example #1 - Laminate Bamboo stiffened Aluminium Curtainwall



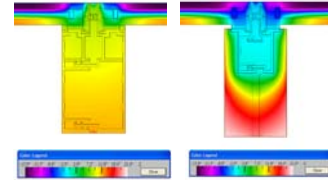
Mass Aluminium (kg/m <sup>2</sup> )	2
Mass Timber (kg/m <sup>2</sup> )	5
Mullion U-value (W/m <sup>2</sup> K)	5.1
Panel U-value (W/m <sup>2</sup> K)	1.77
Embodied carbon of mullions (kgCO <sub>2</sub> /m <sup>2</sup> )	19.3
Embodied energy of mullions (MJ/m <sup>2</sup> )	314



aurecon

Comparison of curtainwall performance

	Traditional aluminium framed curtainwall mullion	Laminated bamboo framed curtainwall mullion
Mass Aluminium (kg/m <sup>2</sup> )	5.7	2
Mass Timber (kg/m <sup>2</sup> )	-	5
Mullion U-value (W/m <sup>2</sup> K)	10.3	5.1
Panel U-value (W/m <sup>2</sup> K)	2.38	1.77
Embodied carbon of mullions (kgCO <sub>2</sub> /m <sup>2</sup> )	46.7	19.3
Embodied energy of mullions (MJ/m <sup>2</sup> )	878	314



Therm output showing isotherm gradients

aurecon

Feature Glazing



aurecon

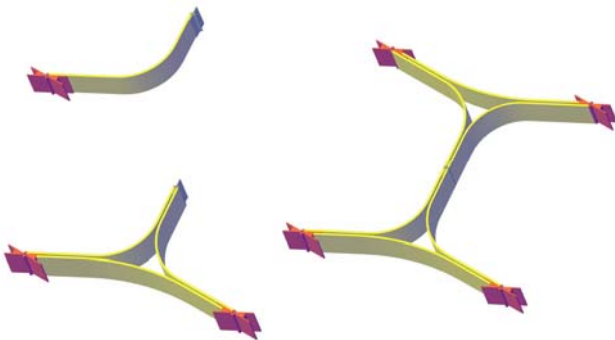
Comparison of Feature Walls

- \*12m span at 2.4m centres
- \*Glass, reverse tensioned cable and solid laminate beam similar embodied performance
- \*Secondary Structure greatly influences the total embodied energy / carbon

	Aluminium Box mullion	Glass fin mullion	Steel box mullion	Steel reverse tension cable	Laminated bamboo mullion
Size	415x150x10 RHS	420x36 fin	270x150x10 RHS	2x 16mm dia rods 1000mm deep profile	400x150 solid
Mass (kg/m <sup>2</sup> )	13.1	15.7	26.2	15.2	19.5
Embodied carbon of mullions (kgCO <sub>2</sub> /m <sup>2</sup> )	107.6	19.9	49.2	27.3	12.9
Embodied energy of mullions (MJ/m <sup>2</sup> )	2009	441	664	373.4	234
Sketch of Entrance Facade					

aurecon

An alternate wall concept – hybrid modular wall

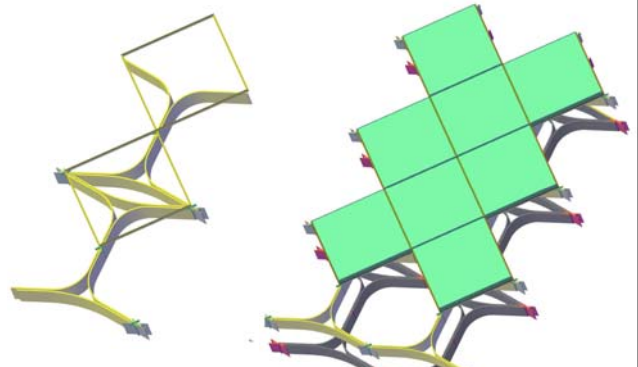


aurecon

Small repeatable elements make up modular units made from renewable natural materials

We acknowledge fymt architects for their unpublished concepts which were drawn from work of Daniel Coll I Capdeville on Strip Morphologies that have inspired this design

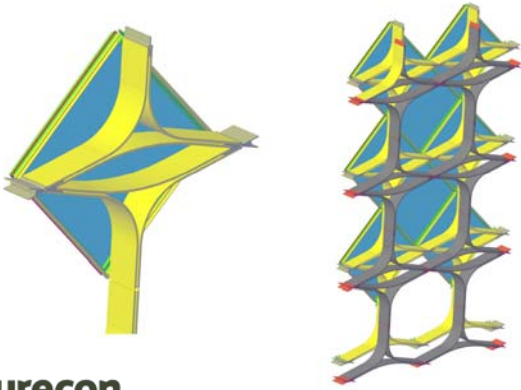
An alternate wall concept – hybrid modular wall



aurecon

Repeatable modular units join together to span small and layered to span larger distances

An alternate wall concept – hybrid modular wall



aurecon

An alternate material and an alternate system

Greater efficiency in thermal performance, improved health and Indoor Environmental Quality, reduced footprint through embodied energy and greater opportunity to sequester carbon, better whole of life materials that can be recycled that produce a lightweight, modular, repeatable and improved method of construction.

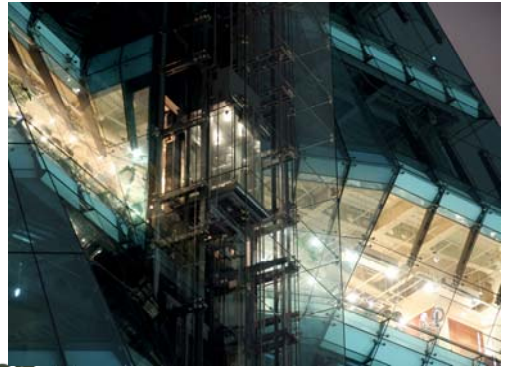
aurecon

Point supported glass



aurecon

Load bearing Lift Shaft



aurecon